



**CONESTOGA-ROVERS
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September 22, 2010

Reference No. 14027-14

Ms. Carolyn Bury
U.S. EPA Region 5
LU-9J
77 West Jackson Blvd
Chicago, IL 60604-3507

Dear Ms. Bury,

Re: Response to August 12, 2010 U.S. EPA letter
Legacy Site Services, LLC - East Plant
Riverview/Wyandotte, Michigan

On behalf of Legacy Site Services, LLC (LSS), Agent for Arkema Inc., Conestoga-Rovers & Associates, Inc. (CRA) has prepared this response to the United States Environmental Protection Agency (U.S. EPA) letter dated August 12, 2010.

As stated in the letter, based on U.S. EPA review of the May 2010 Corrective Measures Study (CMS) report for the LSS, East Pant (Site), additional information was requested, as follows:

- 1) **Groundwater Alternative 1** - U.S. EPA requested an estimate of the time required for the operation of the Interim Remedial Measure (IRM) to reach Michigan Act 451, Part 201 media cleanup standards in Area 17, including standards for dense non aqueous phase liquids (DNAPL), DNAPL dissolved-phase plume(s), chloroform plume, and any other plumes being treated by the IRM.

Refer to Attachment A for a response to this comment.

- 2) **DNAPL Extent Figure** - U.S. EPA indicated that the RCRA Facility Investigation (RFI) Report Figure 2.1 appeared to depict DNAPL extent but that a better extent figure was preferred, if available.

In response to this comment, CRA created a figure depicting observations pertaining to potential NAPL in the Halowax Area. The figure, provided as Attachment B, depicts results of a review of over 50 soil boring logs (all of the boring logs reviewed are included in the RFI Report, Appendix C). Color coding is utilized on the figure to show where soil boring log descriptions and/or monitoring well measurements do not indicate the presence of NAPL; where potential NAPL was observed in soil boring logs; and where NAPL has been physically measured in existing wells. Borings colored to indicate potential NAPL are generally locations where staining, odors or other potential NAPL indicators were observed

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on the boring logs (oil/sheen/product references), but it is important to note that measurable free product has not been confirmed at those locations.

As shown on the figure, data suggests that there is not a contiguous DNAPL plume in Area 17. DNAPL appears at relatively isolated locations mainly in the northeastern quadrant of the area.

It is important to note that Figure 2.1 of the RFI is a Site Plan, depicting Solid Waste Management Unit (SWMU) boundaries; it is not a DNAPL extent Figure. A DNAPL extent figure was not created as part of the RFI or CMS reports as the IRM located in Area 17 (the "Hallowax Area") encompasses the area in which DNAPL has been identified and has been effective at controlling risks in the area. As mentioned in the CMS Report, the IRM consists of containment, recovery and treatment elements, which are collectively:

- Capturing and removing DNAPL from the subsurface (approximately 385 gallons to date)
- Capturing and treating impacted groundwater within Area 17 (approximately 850,000 gallons to date)
- Limiting migration of impacted groundwater toward the Trenton Channel
- Preventing migration of impacted groundwater and DNAPL around the southern portion of the containment wall

Additionally, together with the barrier wall extension (slurry wall) along the northern property line, which is described in detail in the CMS Report, the containment and recovery system serves the dual purpose of containing (and ultimately collecting and treating) groundwater impacts in Area 17.

- 3) **Area 17 IRM Monitoring Wells** - U.S. EPA requested quarterly monitoring of four monitoring wells (MW025, IRM-MW-1, IRM-MW-2 and IRM-MW-3) for VOCs and SVOCs to evaluate the effectiveness of the system.

CRA collected groundwater samples from each of the above-mentioned wells on August 13, 2010, the results of which are provided in Attachment C.

As shown in Attachment C, limited constituents were detected above the most conservative Michigan Act 451, Part 201 groundwater criteria (criteria protective of the residential drinking water pathway or the groundwater-surface water interface [GSI], depending on the constituent) in IRM-MW-1, IRM-MW-2 and IRM-MW-3, which are located within the containment area and subject to removal by the existing recovery wells. No constituents



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were detected in MW025 at concentrations above the most conservative Michigan Act 451, Part 201 groundwater criteria. MW025 is located at the southern end of the sheet pile wall to monitor the effectiveness of the containment system at preventing migration of Halowax constituents. The results of the recent sampling, as well as the results of sampling conducted in August and September 2006 (detailed in the CMS Report), demonstrate that the containment system is successfully preventing migration of the Halowax constituents.

We trust that this satisfies your requirements at this time. If you should have any questions or comments or require further clarification, please contact Mr. Michael Pinto at (610) 594-4435.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

Peter S. Swanson, P.E.

PSS/1/Det.

Encl.

cc: Michael Pinto, LSS
Michael Bollinger, Beazer East
Tim King, Union Carbide
Peter Quackenbush, MDNRE
Lawrence Aubuchon, MDNRE

ATTACHMENT A



**CONESTOGA-ROVERS
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MEMORANDUM

TO: Mike Pinto REF. NO.: 014027-14

FROM: Alan Weston/adh/1 *PSS FOR AW* DATE: September 15, 2010

C.C.: Pete Swanson

RE: Potential for Halowax and Chloroform Degradation
Halowax Area, Arkema, East Plant, Wyandotte, Michigan

INTRODUCTION

Based on their review of the May 2010 Corrective Measures Study (CMS) Report for the Arkema, East Plant, located in Riverview and Wyandotte, Michigan (Site), the United States Environmental Protection Agency (U.S. EPA) requested additional information regarding the potential for degradation of dense non-aqueous phase liquids (DNAPL) in Area 17. Specifically, USEPA requested an estimate of the time required for the operation of the Interim Remedial Measure (IRM) to reach the Part 201 media cleanup standards in Area 17, including standards for the DNAPL, DNAPL dissolved-phase plume(s), chloroform plume, and any other plumes being treated by the IRM was requested.

U.S. EPA requested that the estimate was to be based on: Site hydrogeology, including an assessment of the total DNAPL volume based upon its footprint and thickness across the footprint, an assessment of the current physical stability of the DNAPL under the natural and anthropogenic hydraulic gradients, and a summary of past DNAPL removal rates, as well as a projection of the future DNAPL removal rates. If contaminant decay/degradation was an important process in the evolution of the dissolved contaminant plume, or other plumes, the geochemistry of the decay/degradation process(es) was also to be described. Additionally, an assessment of how the DNAPL weathers over time (as constituents dissolve, volatilize, degrade, sorb, and become removed) was also requested for the estimate.

Conestoga-Rovers & Associates (CRA) provides a discussion below in Response to U.S. EPA's request.

DEGRADATION ASSESSMENT

DNAPL Concentrations and Solubility

Review of well and boring data for Area 17 showed that DNAPL observations were most common in the northeast corner of the area. Generally the observations were of isolated DNAPL pockets. There does not appear to be a contiguous DNAPL plume.

The highest groundwater chloroform concentrations were observed in well MW-017 at 1,800 milligrams per liter (mg/L). The solubility of chloroform in water is 7,950 mg/L, which suggests that chloroform DNAPL

was not present at well MW-017. Similarly, chloroform was either not detected or was present at levels below 50 mg/L in the other wells in the area (MW-009, MW-10A, MW-016, MW-022, MW-109, and MW-209) suggesting that chloroform DNAPL was not present in the wells or the areas surrounding the wells.

Representative impacts associated with Halowax in Area 17 were determined by review of Area 17 soil boring data. The range of concentrations (excluding compounds detected below 1 mg/L) is as follows: 1,2-dichlorobenzene at 11 mg/kg; 1,4-dichlorobenzene at 1.6 to 18 mg/kg; hexachlorobenzene at 1.2 to 1,200 mg/kg; 1,4-dichloronaphthalene at 1 to 440 mg/kg; octachloronaphthalene at 1 to 46 mg/kg; 1-chloronaphthalene at 1 to 1,000 mg/kg; 2-chloronaphthalene at 61 to 140 mg/kg; naphthalene at 1.3 to 14,000 mg/kg; and total Halowax at 1.6 to 10,000 mg/kg. These results suggest that the Halowax associated compounds were present at no more than 2 to 3 percent in the soils. In our experience with mobility assessments of similar NAPLs, the Halowax would not be expected to be mobile at that level. It would be absorbed on the soil and would be visible only as a discoloration. This is consistent with observations of soil samples collected from the borings which identified stained soil, but generally no free product. Furthermore, the log octanol/water partition coefficient of the most soluble Halowax compound (1,2-dichlorobenzene with a solubility of 156 mg/L) is 3.38, meaning that this compound has a much greater affinity for the DNAPL than water, thereby limiting its potential mobility by dissolution from DNAPL and advective transport by groundwater.

Biodegradation

Chloroform and the chlorinated Halowax compounds biodegrade under anaerobic groundwater conditions. Groundwater conditions are anaerobic in the area as the oxidation reduction potential (ORP) and dissolved oxygen (DO) data for wells MW-009 and MW-017 demonstrate (MW-009: ORP -298 millivolts (mV), DO 0.24 mg/L; MW-017: ORP -250 mV, DO 0.21 mg/L). Therefore, conditions in the area are suitable for biodegradation to proceed. Metals are present in the soils and could potentially inhibit biodegradation. Two metals of particular concern are lead and chromium. Lead can be tolerated by soil bacteria up to 5,000 milligrams per kilogram (mg/kg), while chromium (either III or VI) has toxic effects at 100 mg/kg. Review of the soil boring data for Area 17 showed that the lead concentrations range from 26.3 to 1,410 mg/kg, and chromium concentrations range from 6.7 to 64.8 mg/kg. Therefore, neither of these metals should inhibit biodegradation. Anaerobic biodegradation proceeds via sequential loss of chlorine atoms until the core hydrocarbon molecule remains. Chloroform biodegrades sequentially to dichloromethane, chloromethane, and methane. Methane is a gas and would be lost from the soil or could be converted to carbon dioxide. Both methane and carbon dioxide are non-toxic compounds and are considered endpoints of the biodegradation process. Chloronaphthalenes biodegrade similarly, by sequential chlorine loss to naphthalene, which would be biodegraded to methane or carbon dioxide. Chlorobenzenes also biodegrade similarly under anaerobic conditions. The biodegradation half-life of a compound describes the time for the compound to complete the biodegradation pathway.

The half-life for chloroform anaerobic biodegradation in soils has been reported as between 1 week and 4 weeks. These data are primarily for laboratory studies where conditions are optimized. Half-lives are typically longer under field conditions. Therefore, the longer half-life is probably more appropriate for chloroform. A review of Halowax biodegradation by Helm et al did not identify any information on Halowax biodegradation rates. A 28-day study by Jarnberg et al did not show degradation, but the study time was too short to reveal degradation. Degradation half-lives are available for some of the components of Halowax and are shown in the table below.

| <i>Compound</i> | <i>Half-life in Soil Range</i> |
|-----------------------|--------------------------------|
| 1,2-dichlorobenzene | 1 to 6 months |
| Naphthalene | 1 to 8 months |
| Hexachloronaphthalene | 1 to 4 years |
| Octachloronaphthalene | 1 to 4 years |
| Hexachlorobenzene | 10.6 to 22.9 years |

Chemicals must be dissolved to biodegrade; as discussed previously, the dissolution of the more soluble Halowax constituents will be retarded by the affinity for the organic matrix. Therefore, the longer half-lives are likely more representative of the degradation rate for Halowax. Hexachloronaphthalene and octachloronaphthalene both have upper limit half-lives of 4 years, which would be a reasonably conservative estimate for the biodegradation of Halowax. If a half-life of 4 weeks is used for chloroform, 95 percent should be degraded in 5 months and 99 percent in 7 months. However, chloroform is present with a mixture of other compounds that will tend to retard its biodegradation. In October 2006, the ITG performed a treatability study that included an evaluation of enhanced biodegradation for chloroform-impacted Site soils (provided in Appendix D of the CMS Report). The study showed that 5 years would be required to complete the enhanced biodegradation of chloroform at the Site. This estimate was obtained for chloroform in the saturated soil matrix and, therefore, is a considered better estimate than the theoretical estimate discussed above. For Halowax, 95 percent should be degraded in 5 to 20 years and 99 percent should be degraded in 7 to 28 years. These are theoretical estimates and do not take field conditions into account. However, as discussed above, field conditions do appear to be favorable for biodegradation to proceed.

CONCLUSION

Review of the data suggests that there is not a large DNAPL plume in Area 17. DNAPL was present at relatively isolated locations mainly in the northeastern quadrant of the area. Soil and groundwater concentrations generally do not approach the solubility of chloroform or the Halowax compounds, which support the conclusion that DNAPL is not widespread. The groundwater conditions are favorable for anaerobic biodegradation. Therefore, contaminant decay/degradation/weathering will be an important process in the evolution of the dissolved contaminant plume. Anaerobic biodegradation proceeds by sequential loss of chlorine from the core molecule, after which the core molecule will degrade to methane or carbon dioxide. Based on the theoretical half-life data, 99 percent of the chloroform in the area will biodegrade in less than a year. The results of our treatability study showed that enhanced biodegradation of chloroform in the saturated soil matrix would require 5 years. This is considered a better estimate for chloroform biodegradation than the theoretical prediction. Between 7 and 28 years will be required to degrade 99 percent of the Halowax. This estimate was based on highly chlorinated naphthalene half-life data and, therefore, is considered conservative.

REFERENCES

Physical and Biological Parameters

- Howard, P.H., Handbook of Fate and Exposure Data for Organic Chemicals, Lewis Publishers Inc., Chelsea, MI, 1991.
- Howard, P.H., Boething R.S., Jarvis W.F., Meylan W.M., and Michalenko E.M., Handbook of Environmental Degradation Rates., Lewis Publishers Inc., Chelsea, MI, 1991.

Mackay, D., Shui, W.Y., Ma, K.C., Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals, Lewis Publishers Inc., Chelsea, MI, 1992.

Halowax Biodegradation

Jarnberg, U.S., Asplund, L.T., Egegack, A-L., Jansson, B., Unger, M., and Wideqvist, U., Polychlorinated Naphthalene Congener Profiles in Background Sediments Compared to a Degraded Halowax 1014 Technical Mixture. Environmental Science & Technology, 33 (1): 1-6, 1999.

Helm, P.A., Kannan, K., and Bidleman, T.F. Polychlorinated Naphthalenes in the Great Lakes, Handbook of Environmental Chemistry, 5 (Part N): 267-306, 2006.

ATTACHMENT B

ATTACHMENT C

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
(2010 RESULTS - UNVALIDATED)
EAST PLANT
RIVERVIEW/WYANDOTTE, MICHIGAN

| Sample Location | | Most Conservative | MW025 | MW025 | MW025 | MW025 | IRM-MW-1 | IRM-MW-1 | IRM-MW-2 | IRM-MW-3 |
|---|------|----------------------------|------------------|------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Sample Identification | | Michigan Act 451, Part 201 | EA03-EP-MW025-01 | EA03-EP-MW025-02 | GW-14027-091306-KG-003 | GW-14027-081310-EV-001 | GW-14027-081310-EV-002 | GW-14027-081310-EV-003 | GW-14027-081310-EV-004 | GW-14027-081310-EV-005 |
| Sample Date | | Criteria ¹ | 8/16/2006 | 8/13/2006 | 9/13/2006 | 8/13/2010 | 8/13/2010 | 8/13/2010 | 8/13/2010 | 8/13/2010 |
| Sample Type | | | Grab | Duplicate | Grab | Grab | Grab | Duplicate | Grab | Grab |
| <u>Semi-Volatile Organic Compounds</u> | | <u>Units</u> | | | | | | | | |
| 2,2'-Oxybis(1-chloropropane) (bis(2-Chloroisopropyl) ether) | mg/L | -- | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 2,4,5-Trichlorophenol | mg/L | 0.73 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 2,4,6-Trichlorophenol | mg/L | 0.0044 | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.0048) |
| 2,4-Dichlorophenol | mg/L | 0.019 | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.012) |
| 2,4-Dimethylphenol | mg/L | 0.37 | ND(0.005) | ND(0.005) | 0.0008 J | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 2,4-Dinitrophenol | mg/L | -- | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.024) |
| 2,4-Dinitrotoluene | mg/L | 0.0077 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 2,6-Dinitrotoluene | mg/L | -- | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 2-Chloronaphthalene | mg/L | 1.8 | ND(0.005) | ND(0.005) | ND(0.005) | 0.00062 J | 0.013 | 0.015 | 0.0013 J | ND(0.006) |
| 2-Chlorophenol | mg/L | 0.022 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.0033 J | ND(0.006) |
| 2-Methylnaphthalene | mg/L | 0.26 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 2-Methylphenol | mg/L | 0.071 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.015 | ND(0.006) |
| 2-Nitroaniline | mg/L | -- | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.024) |
| 2-Nitrophenol | mg/L | 0.02 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 3,3'-Dichlorobenzidine | mg/L | 0.0003 | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| 3-Nitroaniline | mg/L | -- | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.024) |
| 4,6-Dinitro-2-methylphenol | mg/L | 0.02 | R | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.024) |
| 4-Bromophenyl phenyl ether | mg/L | -- | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 4-Chloro-3-methylphenol | mg/L | 0.0074 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 4-Chloroaniline | mg/L | -- | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.012) |
| 4-Chlorophenyl phenyl ether | mg/L | -- | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| 4-Methylphenol | mg/L | 0.071 | ND(0.005) | ND(0.005) | 0.0011 J # | ND(0.005) | ND(0.005) | ND(0.005) | 0.01 # | ND(0.006) |
| 4-Nitroaniline | mg/L | -- | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.024) |
| 4-Nitrophenol | mg/L | -- | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.02) | ND(0.024) |
| Acenaphthene | mg/L | 0.019 | ND(0.005) | ND(0.005) | ND(0.005) | 0.00042 J | ND(0.005) | ND(0.005) | ND(0.005) | 0.00095 J |
| Acenaphthylene | mg/L | 0.052 | ND(0.005) | ND(0.005) | 0.00067 J | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.0014 J |
| Acetophenone | mg/L | 1.5 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.00061 J | ND(0.006) |
| Anthracene | mg/L | 0.043 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Atrazine | mg/L | 0.003 | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.0036) |
| Benzaldehyde | mg/L | -- | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.012) |
| Benzo(a)anthracene | mg/L | 0.0021 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| Benzo(a)pyrene | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| Benzo(b)fluoranthene | mg/L | 0.0015 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| Benzo(g,h,i)perylene | mg/L | 0.001 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| Benzo(k)fluoranthene | mg/L | 0.001 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| Biphenyl (1,1-Biphenyl) | mg/L | -- | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | 0.0016 J | ND(0.012) |
| bis(2-Chloroethoxy)methane | mg/L | -- | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| bis(2-Chloroethyl)ether | mg/L | 0.002 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | 0.00088 J | ND(0.0012) |
| bis(2-Ethylhexyl)phthalate (DEHP) | mg/L | 0.006 | ND(0.005)U | ND(0.005)U | ND(0.005)U | ND(0.005) | ND(0.005) | ND(0.005) | 0.00096 J | ND(0.006) |
| Butyl benzylphthalate (BBP) | mg/L | 0.014 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Caprolactam | mg/L | 5.8 | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.012) |
| Carbazole | mg/L | 0.01 | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | 0.0015 J | 0.0005 J |
| Chrysene | mg/L | 0.0016 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.0012) |
| Dibenz(a,h)anthracene | mg/L | 0.002 | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.0024) |
| Dibenzofuran | mg/L | 0.004 | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.004) | ND(0.0048) |
| Diethyl phthalate | mg/L | 0.11 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.00062 J |
| Dimethyl phthalate | mg/L | 73 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Di-n-butylphthalate (DBP) | mg/L | 0.0097 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Di-n-octyl phthalate (DnOP) | mg/L | 0.13 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Fluoranthene | mg/L | 0.0016 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | 0.00038 J |
| Fluorene | mg/L | 0.012 | ND(0.005) | ND(0.005) | 0.00068 J | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Hexachlorobenzene | mg/L | 0.0002 | ND(0.0002) | ND(0.0002) | ND(0.0002) | ND(0.0002) | ND(0.0002) | ND(0.0002) | ND(0.0002) | ND(0.00024) |
| Hexachlorobutadiene | mg/L | 0.00005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | 0.004 | | ND(0.0012) |
| Hexachlorocyclopentadiene | mg/L | 0.05 | R | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Hexachloroethane | mg/L | 0.0067 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.0034 J | ND(0.005) | ND(0.006) |
| Indeno(1,2,3-cd)pyrene | mg/L | 0.002 | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.0024) |
| Isophorone | mg/L | 0.57 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Naphthalene | mg/L | 0.013 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 0.04 | | 0.04 | ND(0.006) |
| Nitrobenzene | mg/L | 0.0034 | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.003) | ND(0.0036) |
| N-Nitrosodi-n-propylamine | mg/L | 0.005 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| N-Nitrosodiphenylamine | mg/L | 0.27 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Pentachlorophenol | mg/L | 0.001 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Phenanthrene | mg/L | 0.0024 | 0.00046 J | 0.00045 J | 0.00045 J | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.0024) |
| Phenol | mg/L | 0.21 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |
| Pyrene | mg/L | 0.14 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.006) |

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
(2010 RESULTS - UNVALIDATED)
EAST PLANT
RIVERVIEW/WYANDOTTE, MICHIGAN

| Sample Location | | Most Conservative | MW025 | MW025 | MW025 | MW025 | IRM-MW-1 | IRM-MW-1 | IRM-MW-2 | IRM-MW-3 |
|--|------|----------------------------|------------------|------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Sample Identification | | Michigan Act 451, Part 201 | EA03-EP-MW025-01 | EA03-EP-MW025-02 | GW-14027-091306-KG-003 | GW-14027-081310-EV-001 | GW-14027-081310-EV-002 | GW-14027-081310-EV-003 | GW-14027-081310-EV-004 | GW-14027-081310-EV-005 |
| Sample Date | | Criteria ¹ | 8/16/2006 | 8/16/2006 | 9/13/2006 | 8/13/2010 | 8/13/2010 | 8/13/2010 | 8/13/2010 | 8/13/2010 |
| Sample Type | | | Grab | Duplicate | Grab | Grab | Grab | Duplicate | Grab | Grab |
| <u>Volatile Organic Compounds</u> | | <u>Units</u> | | | | | | | | |
| 1,1,1-Trichloroethane | mg/L | 0.2 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,1,2,2-Tetrachloroethane | mg/L | 0.0085 | ND(0.001)UJ | ND(0.001)UJ | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,1,2-Trichloroethane | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,1-Dichloroethane | mg/L | 0.74 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,1-Dichloroethene | mg/L | 0.007 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,2,4-Trichlorobenzene | mg/L | 0.03 | ND(0.005) | ND(0.005) | ND(0.005) | 0.00034 J B | ND(62) | ND(62) | ND(0.033) | ND(0.012) |
| 1,2-Dibromo-3-chloropropane (DBCP) | mg/L | 0.0002 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,2-Dibromoethane (Ethylene dibromide) | mg/L | 0.00005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,2-Dichlorobenzene | mg/L | 0.016 | 0.00051 J | 0.00048 J | 0.00059 J | 0.0058 | ND(12) | ND(12) | 0.029 | 0.007 |
| 1,2-Dichloroethane | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,2-Dichloropropane | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| 1,3-Dichlorobenzene | mg/L | 0.0066 | ND(0.001) | ND(0.001) | ND(0.001) | 0.0027 | ND(12) | ND(12) | 0.025 | 0.0045 |
| 1,4-Dichlorobenzene | mg/L | 0.013 | 0.00034 J | 0.00031 J | 0.00037 J | 0.0073 B | ND(12) | ND(12) | 0.15 B | 0.0066 B |
| 2-Butanone (Methyl ethyl ketone) (MEK) | mg/L | 2.2 | ND(0.025)UJ | ND(0.025) | 0.00048 J | ND(0.025) | ND(310) | ND(310) | ND(0.17) | ND(0.062) |
| 2-Hexanone | mg/L | 1 | ND(0.05)UJ | ND(0.05) | ND(0.05) | ND(0.05) | ND(620) | ND(620) | ND(0.33) | ND(0.12) |
| 4-Methyl-2-pentanone (Methyl isobutyl ketone) (M | mg/L | 1.8 | ND(0.05)UJ | ND(0.05)UJ | ND(0.05) | ND(0.05) | ND(620) | ND(620) | ND(0.33) | ND(0.12) |
| Acetone | mg/L | 0.73 | ND(0.025) | ND(0.025) | ND(0.025)U | ND(0.025) | ND(310) | ND(310) | ND(0.17) | ND(0.062) |
| Benzene | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | 0.00063 J | ND(12) | ND(12) | 0.33 | 0.0073 |
| Bromodichloromethane | mg/L | 0.08 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Bromoform | mg/L | 0.08 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Bromomethane (Methyl bromide) | mg/L | 0.01 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Carbon disulfide | mg/L | 0.8 | ND(0.005) | ND(0.005) | 0.00041 J | ND(0.005) | 1.7 J | ND(62) | ND(0.033) | ND(0.012) |
| Carbon tetrachloride | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Chlorobenzene | mg/L | 0.047 | 0.0013 | 0.0012 | 0.0017 | 0.035 | ND(12) | ND(12) | 0.46 | 0.091 |
| Chloroethane | mg/L | 0.43 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Chloroform (Trichloromethane) | mg/L | 0.08 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | 690 | 710 | 0.0041 J | 0.00061 J |
| Chloromethane (Methyl chloride) | mg/L | 0.26 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| cis-1,2-Dichloroethene | mg/L | 0.07 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| cis-1,3-Dichloropropene | mg/L | -- | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Cyclohexane | mg/L | -- | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Dibromochloromethane | mg/L | 0.08 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Dichlorodifluoromethane (CFC-12) | mg/L | 1.7 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Ethylbenzene | mg/L | 0.018 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | 0.0012 J | ND(0.0025) |
| Isopropyl benzene | mg/L | 0.8 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(62) | ND(62) | ND(0.033) | ND(0.012) |
| Methyl acetate | mg/L | -- | ND(0.01) | ND(0.01) | ND(0.01) | ND(0.01) | ND(120) | ND(120) | ND(0.067) | ND(0.025) |
| Methyl cyclohexane | mg/L | -- | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Methyl tert butyl ether (MTBE) | mg/L | 0.04 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | ND(62) | ND(62) | ND(0.033) | ND(0.012) |
| Methylene chloride | mg/L | 0.005 | ND(0.005) | ND(0.005) | ND(0.005) | ND(0.005) | 41 J | 44 J | ND(0.033) | ND(0.012) |
| Styrene | mg/L | 0.08 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Tetrachloroethene | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Toluene | mg/L | 0.14 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | 0.12 | 0.00061 J |
| trans-1,2-Dichloroethene | mg/L | 0.1 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| trans-1,3-Dichloropropene | mg/L | -- | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Trichloroethene | mg/L | 0.005 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Trichlorofluoromethane (CFC-11) | mg/L | 2.6 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Trifluorotrichloroethane (Freon 113) | mg/L | 0.032 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Vinyl chloride | mg/L | 0.002 | ND(0.001) | ND(0.001) | ND(0.001) | ND(0.001) | ND(12) | ND(12) | ND(0.0067) | ND(0.0025) |
| Xylene (total) | mg/L | 0.035 | ND(0.002) | ND(0.002) | ND(0.002) | ND(0.002) | ND(25) | ND(25) | 0.0071 J | ND(0.005) |

Notes:

- 1) The most conservative Michigan Act 451, Part 201 criteria is the lower of the Groundwater/Surface Water Interface (GSI) criteria or the Generic Residential Drinking Water Criteria.
- 2) "--" - Criterion does not exist
- 3) mg/L - milligrams per liter (parts per million)
- 4) ND() - Not detected above the value in parenthesis.
- J - Estimated concentration.
- UJ - Estimated reporting limit.
- R - Rejected.
- # - The reported concentration may be either 3-methylphenol and/or 4-methylphenol.
- B - Laboratory qualifier: Method blank contamination. The associated method blank contains the target analyte at a reportable level.